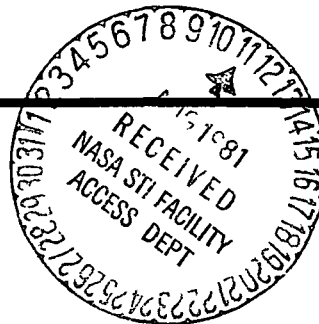


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## PIONEER 10 AT 'SILVER AU' DESCRIBES SUN'S ATMOSPHERE

Pioneer 10, almost 4 billion kilometers (2.5 billion miles) from the Sun, has now provided the most complete picture yet available of the Sun's atmosphere and solar space. The findings represent new understanding of the solar system and characteristics of stars in the universe

Pioneer is making man's first trip out of the solar system and is farther out than any previous spacecraft

On July 26, Pioneer 10 passed the 25 Astronomical Unit (AU) mark, the Silver AU. An astronomical unit is the distance from the Earth to the Sun, about 150 million km (93 million mi )

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(NASA-News-Release-81-110) PIONEER 10 AT  
SILVER AU DESCRIBES SUN'S ATMOSPHERE  
(National Aeronautics and Space  
Administration) 8 p

From 25 AU, the Earth is a pinpoint never more than 2 3 degrees away from a Sun still intensely bright, but no larger than a pin head

Pioneer 10 is now between Uranus and Neptune's orbits. It takes 3 hours and 28 minutes for spacecraft data, traveling at the speed of light, to reach the Pioneer Operations Center at NASA's Ames Research Center, Mountain View, Calif

Since it was launched in March 1972, Pioneer 10 has been sending back data on the heliosphere, the Sun's atmosphere.

The 1 6 million kilometers per hour (1 million miles per hour) solar wind forms the solar atmosphere. Like the Sun, most stars have their own atmospheres. By describing the atmosphere of our Sun, which is typical of the majority of stars in the galaxy, Pioneer 10 is making a major step in understanding how the universe is put together, according to Dr Aaron Barnes, Pioneer Investigator, Solar Winds, at NASA-Ames.

Pioneer 10 findings paint the following new and detailed picture of the Sun's atmosphere

The heliosphere is now believed to be a huge, tear-shaped magnetic bubble created by the solar wind. It gets its tear-drop shape from streamlining due to the motion of the solar system through the interstellar gas. The skin of the bubble, the boundary region between stellar and interstellar gas, is believed to lie between 50 and 100 AU from the Sun

The solar wind, which consists of streams of ionized gases, travels at an average of 1 6 million km/hr (1 million mph) away from the Sun in all directions, dragging the Sun's magnetic field with it. This bubble, which probably extends far beyond Pluto, is believed to breathe, expanding and contracting like a giant cosmic lung with each 11-year solar cycle, according to Dr. John Simpson, Pioneer Investigator, High Energy Particles, University of Chicago.

The most recent findings show that as storms on the Sun build up toward maximum solar activity, they send out shock waves throughout the bubble that cause ripples like those created by a pebble dropped at the edge of a pond. These ripples may live in the heliosphere for over a year, according to Dr. Frank McDonald, Pioneer Investigator, High Energy Particles, NASA's Goddard Space Flight Center, Greenbelt, Md. The ripples may cause it to change shape like a huge jellyfish, as well as expand and contract.

This long-lived solar storm turbulence accelerates low energy cosmic ray particles coming in from the galaxy, deflecting them out of the solar system, and shielding the planets. Near solar storm maximum, even high energy (high speed) cosmic ray particles are shut out. However, Pioneer is finding, as distance from the Sun increases, more and more cosmic ray particles penetrate the heliosphere.

Solar storms, also called solar flares, apparently trigger the Earth's weather cycles. They cause electro-magnetic storms and radio blackouts, distort navigation and overload power systems on Earth.

The Sun's magnetic field, like the Earth's, has two poles. The entire heliosphere is split by a current sheet, extending out from the solar equator. The sheet separates the northern magnetic hemisphere from the southern magnetic hemisphere. This current sheet, and the interplanetary magnetic field, is warped by solar storms, making the Sun look like it is in the middle of a flapping, circular electric flying carpet, says Dr. Edward Smith, Pioneer Investigator, Magnetic Fields, Jet Propulsion Laboratory, Pasadena, Calif. Scientists now believe the current sheet extends to the heliopause, the boundary region between the Sun's atmosphere and the interstellar gas (the medium between the stars).

Near Earth, Pioneer data shows, the solar wind blowing away from the Sun is made up of from two to 10 huge fast and slow streams. These streams create turbulence as they bump each other. By the time the solar wind passes Uranus, the slow streams have caught up with the fast streams, creating one stream that travels at a speed of the two streams combined. Here the stream boundary turbulence almost disappears.

Within the solar system, one planet behaves as if it were a small sun. Jupiter, at 5 AU from the Sun, spews out high-speed streams of electrons that travel at least 3 2 billion km (2 billion mi ) in the solar system, producing a lighthouse effect as they rotate with the planet. Because these clearly non-solar electrons are bent by the Sun's magnetic field, they are good tools to investigate the character of this magnetic field. (This August, as the Voyager 2 spacecraft flies close by Saturn, solar wind investigators will have a good chance to study magnetic field and particle interaction between two planets. Saturn is expected to lie within the magnetic wake of Jupiter (due to the conjunction of those two planets) and Saturn's own magnetosphere could well be warped by the Jupiter magnetotail.)

Before the discovery of the Jovian electrons, scientists felt planets had little effect on the heliosphere, according to Dr. Palmer Dyal, Pioneer project scientist, Solar Winds, at NASA-Ames. However, these electrons could cause an interchange of energy between Jupiter and the heliosphere, Dyal said. Jupiter appears to be losing energy while the rest of the heliosphere is gaining energy.

"Jupiter seems to have an immense effect on the whole solar system," Dyal said.

Scientists expect Pioneer 10 to fill in more pieces of the puzzle as it continues its escape from the solar system.

"We expect solar effects to decrease farther out," predicted McDonald. "We should see dramatic increases in incoming low-energy cosmic ray particles from the galaxy, which dominate the outer heliosphere. We will find out how many of these galactic particles there really are. We expect things to be very exciting."

Barnes summed up the importance of the Pioneer 10 findings:

"This is our first chance to begin to realize how a star (the Sun) interacts with its environment. We now have most elements of the environment of a star in a galaxy."

Many of Pioneer 10's findings surprised scientists and reversed earlier theories. But perhaps the most significant was the extent of the Sun's influence.

The discovery that the heliosphere extends to 25 AU and perhaps as far as 100 AU means that "if you were living on any other planet, you would find a solar environment surrounding it like that surrounding Earth. This would include: a constant solar wind, buffets by solar magnetic storms, and, in many cases radiation belts," said Dr. James Van Allen, University of Iowa, who discovered Earth's two radiation belts, now called the Van Allen Belts.

Pioneer 10 data can be used to forecast "solar" conditions for Voyager 2 during its encounter with the planet Uranus in 1986, Van Allen added. The findings also predict similar solar environment conditions for Neptune and Pluto.

Some scientists had predicted that the heliopause, the border between the Sun's atmosphere and interstellar space, would be found at 5 AU

Pioneer 10 completed the first trip to Jupiter in 1973 In 1979, Pioneer 11, which also is now observing the heliosphere, completed the first trip to Saturn

Some other recent Pioneer 10 findings are

- The solar wind was expected by some scientists to slow down with distance, but this has not happened. Almost no motional energy has been lost as heat.
- The primary source of turbulence in the outer heliosphere is solar storms, not solar wind collisions
- Near solar maximum, cosmic ray particles in all velocity ranges (even near light speed) become half as numerous or are shut out completely from the heliosphere.
- For unexplained reasons, streams of Jovian electrons don't wobble as expected from the planet's axial tilt.
- As solar storm activity builds up, the heliosphere is believed to deform into a more oval shape lined up with the Sun's equator, from its rounder shape at solar minimum It also may expand in size.
- Shock waves and turbulence are believed to pile up near the heliosphere boundary with the interstellar gas.

● When the Sun is at solar minimum at the beginning of its 11-year cycle (time of least solar storm activity), a mysterious component of helium creates the most intense radiation of all the low-energy cosmic ray particles in the solar bubble. Though no one knows the exact source of this helium, scientists theorize that it may be part of the neutral interstellar gas that has been ionized by the Sun's ultraviolet rays and somehow accelerated to high speeds. At solar maximum, at the time of greatest solar storm activity, the helium is not measurable at Earth.

Data from the Pioneers, 10 and 11, should continue to be transmitted and received through the end of this decade. Both the Pioneers and Voyagers are powered by several small nuclear-powered thermocouple generators. These power plants are extremely long-lived and reliable. To date, the Deep Space Network has anticipated no problem in receiving the diminutive radio signal from the Pioneers and has continuously improved the equipment at the tracking stations to ensure coverage of the Pioneer missions through 1990.

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